CLIMATE SCIENCE

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Carleton College, Fall 2015
Leighton 426, MW 9:50 am – 11 am MW
Leighton 426, F 9:40 – 10:40 am F

COURSE DESCRIPTION (FROM THE COURSE CATALOG):

In this course, we will explore the state of the science of the modern global climate. The course will include a discussion of the impact of greenhouse gases and aerosol particles on the global climate system, and attention will be paid to understanding global cycles as well as global climate models. In order to understand the underlying science, geoengineering schemes to "fix" the global climate system will be investigated. Throughout the course, our emphasis will be on a quantitative, scientifically rigorous understanding of the complex climate system. Prerequisite: One introductory course in Biology (125 or 126), Chemistry (123 or 128), Geology (any 100-level course), or Physics (two five-week courses or one ten-week course from 131-165) and Math 111 or 215, or consent of the instructor.

OFFICE HOURS:

Open and individual office hours can be found on the Moodle page. Please feel free to come by, or better yet, make an appointment at a mutually convenient time, if you want to talk about the course.

COURSE MOODLE PAGE:

We'll use this page a lot. Please get in the habit of visiting this site regularly.

REQUIRED MATERIALS:

Required Textbook:
Kump, L. R., Kasting, J. F., Crane, R. G., *The Earth System*, 2010, Third Edition, Prentice Hall.

There are multiple ways to get this book:
- From the Carleton bookstore.
- Online, used (make sure it's the Third Edition).
- As an e-book rental for 180 days from the publisher (http://www.coursesmart.com/0321681258/?a=1773944)

Books on Closed Reserve in the library:
I placed a variety of books about aspects of the science of climate change on closed reserve. This is only a small sample of recent titles in our library's holdings. There are many other books which will be useful which you can find on the library shelves.

1. *Climate change : science, strategies, & solutions*, ed. E. Claussen, V.A. Cochran, and D.P. Davis. 2001, Brill.
2. *Environmental modelling : finding simplicity in complexity*, ed. J. Wainwright and M. Mulligan. 2004, Wiley.
3. *Climate change science and policy*, ed. S.H. Schneider. 2010, Island Press.
4. *Geo-engineering climate change : environmental necessity or Pandora's box?*, ed. B.E. Launder and M.T. Thompson. 2010, Cambridge University Press.
5. Archer, D., *The long thaw : how humans are changing the next 100,000 years of Earth's climate*. Science essentials (Princeton, N.J.). 2009, Princeton University Press.

6. Archer, D., *The climate crisis : an introductory guide to climate change*, ed. S. Rahmstorf. 2010, Cambridge University Press.
7. Cohen, S.J., *Climate change in the 21st century*, ed. M.W. Waddell. 2009, McGill-Queen's University Press.
8. Dessler, A.E., *The science and politics of global climate change : a guide to the debate*. 2nd ed. ed, ed. E. Parson. 2010, Cambridge University Press.
9. Goodell, J., *How to cool the planet : geoengineering and the audacious quest to fix earth's climate*. 2010, Houghton Mifflin Harcourt.
10. Mathez, E.A., *Climate change : the science of global warming and our energy future*. 2009, New York: Columbia University Press.
11. Pierrehumbert, R.T., *Principles of planetary climate*. 2010, Cambridge, UK: Cambridge University Press.
12. Richter, B., *Beyond smoke and mirrors : climate change and energy in the 21st century*. 2010, Cambridge, UK: Cambridge University Press.
13. Winsberg, E.B., *Science in the age of computer simulation*. 2010, Chicago: University of Chicago Press.

COURSE GOALS:

By the end of this course, I hope you will be able to:

- Describe complex systems using appropriate terminology.
- Diagram complex systems graphically.
- Qualitatively and quantitatively describe major scientific principles which contribute to the Earth's climate system.
- Explain the major arguments made in support of the idea of human-caused climate change and be able to critique the scientific claims.
- Explain the major arguments made against the idea of human-caused climate change and be able to critique the scientific claims.
- Describe the differences between long and short-lived climate forcers, and assess proposals to address human-caused climate change through technology that impacts emissions of both.
- Gain experience with obtaining and interpreting results from a General Circulation Model (GCM, a climate model).
- Develop hypotheses for future climate responses to specific human behaviors and test those hypotheses using a GCM.
- Assess the roles of uncertainty and risk in our assessment of climate change.
- Use your knowledge to read scientific articles on topics related to climate.
- Provide a critique of policy recommendations related to global climate issues, based on the scientific issues guiding them.
- Apply a scientific understanding of the climate system in other situations, whether your future research, other courses you take, your assessment of policy, or your own personal choices.

OUR COURSE IS PART OF A RESEARCH EFFORT:

We will be using materials developed by a team of faculty (of which I am a member) to develop skills related to thinking about complex systems, through the InTeGrate project. These will be woven into the class, but will require a few additional tasks on your part (filling out surveys, etc.). All of the material covered will be part of the course and will be evaluated as part of your grade. All of the surveys, etc.,

required by the InTeGrate project will be anonymous, and information will not be shared with me; these aspects of the course will not be graded on content, only on completion.

COMPONENTS OF THE COURSE:

We will explore the various aspects of climate science in many ways. Some assignments will be group projects and others will be individual, and the balance between these will be discussed in class. We will work with the material in a variety of ways, including:

- **Readings**: will be from the textbook, books on closed reserve in the library, and the scientific literature. You are expected to complete the readings before the class in which they will be discussed. Specific assignments will be given on the Moodle page.
- **Homework Assignments**: will be given on a regular basis. There will be a combination of quantitative problems, modeling assignments, data gathering, and written work. Late homework assignments will not be accepted unless you have discussed it with me prior to the due date. Specific assignments will be detailed on the Moodle page.
- **Modeling Project**: will be a combination of exercises and independent projects which will be carried out using EdGCM, a global circulation model. You will work on these both in class and out, and you will give a presentation to the class about your project as well as present your results in a written form.
- **Class Discussions**: will be a critical component of the class. You are expected to participate in class discussions by asking and answering questions in group discussions as well as presenting your work.
- **Quizzes and Exams**: will be scattered through the course. There will be one midterm exam and no more than 2 short quizzes throughout the term. The details of these will be discussed in class and the dates will be announced in advance. There will not be a final exam.
- **Academic Civic Engagement Project:** This term, we will work with Tsegaye Nega (ENTS) and the group of students who will go on the winter term OCS program to Ethiopia and Tanzania, to study the climate and health impacts of traditional and high-efficiency cookstoves. This project will be a component of our course and will include both measuring the emissions from the test stoves built by the OCS program students and generation of written material describing the health and climate impacts of traditional cookstove emissions, which will be translated (by Tsegaye) and shared by the students on the OCS program with interested community members.
- **Presentations**: will be required as a way to disseminate information about individual (or small group) projects within the class. One will be signed up for at the beginning of the term, others will pop up more spontaneously (but with warning).
- **Final Project**: will be described in class, and will be in lieu of a final exam. It will most likely be done in teams.

GRADING:

Your grade for this course will be based on the following tentative distribution (any changes will be announced in class):

Class Participation	10 %
Homework Assignments	20 %
Presentation	15 %
Modeling Project	15 %
ACE Cookstove Project	15 %
Quizzes	10 %
Exam	15 %
TOTAL	***100%***

STATEMENT ON CLASSROOM CLIMATE AND GROUP WORK:

It is my expectation that everyone is in this class to succeed and master the material, and that everyone has good insights to offer and good questions to ask. I expect all students in the class to actively support each other's efforts to this end. Throughout this course, you will engage in a variety of assignments which require you to work with others in the class, and it is absolutely imperative that everyone engages in this process fully and treats their classmates with respect. If at any time you experience an interaction with someone else in the class that conflicts with these goals, please bring it to my attention immediately.

STATEMENT ON ACADEMIC INTEGRITY:

Everyone in this course is responsible for the work s/he turns in. You are encouraged to work with and learn from each other on most assignments (as discussed on Moodle), however you should be sure to do the following:

- Acknowledge in writing anyone (fellow student, faculty member, parent, friend from home, *etc*.) who has given you significant help on any work that you submit.
- Turn in your own work.
- Be prepared to do any problem, on your own and without assistance, at any time after it is due.
- Contribute fully to group assignments.

This is applicable to any assignment which is submitted with your name on it, including group work. You are welcome to discuss *ideas* about how to solve homework problems with classmates. However, you must write up the solutions to all the homework problems on your own (rote copying is cheating). All quizzes and exams must be done on your own. Note that academic dishonesty includes not only cheating, fabrication, and plagiarism, but also includes helping other students commit acts of academic dishonesty by allowing them to obtain copies of your work. You are allowed to use the Web for reference purposes, but you may not copy material from any website or any other source without proper citations. In short, all submitted work must be your own. Cases of academic dishonesty will be dealt with strictly. Each such case will be referred to the Academic Standing Committee via the Associate Dean of Students or the Associate Dean of the College. A formal finding of responsibility can result in disciplinary sanctions ranging from a censure and a warning to permanent dismissal in the case of repeated and serious offenses. The academic penalty for a finding of responsibility can range from a grade of zero in the specific assignment to an F in this course.

TENTATIVE COURSE SCHEDULE (MAJOR TOPICS ONLY), SOME READINGS, AND SCHEDULE NOTES:

	DATE	*DAY*	*CLASS TOPIC*	*NOTES AND READING*
WEEK 1	Sept. 14	M	Course Introduction, Project Description	
	Sept. 16	W	Introduction to Systems Thinking*	**Sign up for presentations** Kump Ch. 1
	Sept. 18	F	Working with Complex Systems Diagrams*	Kump Ch. 2
WEEK 2	Sept. 21	M	Energy in the Climate System, Radiative Balance Models	Kump Ch. 3 (up to GHGs)
	Sept. 23	W	Radiative Balance Models, Continued	
	Sept. 25	F	Article Discussion #1	**Presentation 1**
WEEK 3	Sept. 28	M	The Real Atmosphere and Greenhouse Gasses	Kump Ch. 3 (the rest)
	Sept. 30	W	Greenhouse Gasses, GWP, and Short-Lived Climate Polluters	Article on Moodle
	Oct. 2	F	Aerosol Particles, Direct and Indirect Climate Effect	**Presentation 2** Article on Moodle
WEEK 4	Oct. 5	M	Article Discussion #2	Article on Moodle
	Oct. 7	W	Atmospheric Circulation, Convection	Kump Ch. 4
	Oct. 9	F	Atmospheric Circulation, Convection, Continued	**Presentation 3**
WEEK 5	Oct. 12	M	Weather	
	Oct. 14	W	Ocean Circulation, Salinity	Kump Ch. 5
	Oct. 16	F	Putting it all together	**Presentation 4** Article on Moodle
WEEK 6	Oct. 19	M	***Mid-Term Break***	
	Oct. 21	W	Climate Modeling with EdGCM	Kump Ch. 15
	Oct. 23	F	Article Discussion #3	**Presentation 5** Article on Moodle
WEEK 7	Oct. 26	M	Modeling a System*	
	Oct. 28	W	Climate Modeling with EdGCM	
	Oct. 30	F	Feedbacks in a System*	**Presentation 6**
WEEK 8	Nov. 2	M	Quantitative Predictions in Systems*	
	Nov. 4	W	Climate Modeling with EdGCM	
	Nov. 6	F	Article Discussion #4	**Presentation 7** Article on Moodle
WEEK 9	Nov. 9	M	Refuting Climate Deniers	
	Nov. 11	W	Climate Modeling with EdGCM	
	Nov. 13	F	TBD	
WEEK 10	Nov. 16	M	Geoengineering Discussion	**Presentation 8**
	Nov. 18	W	Systems Thinking Synthesis*	
	Nov. 21 - Nov. 23		Final Project Due (Discussed in Class)	

*Related to the InTeGrate project